

Finding Documents in a Digital Institutional Repository: DSpace and Eprints

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Institutional repositories are “digital collections that capture and preserve the intellectual output of universities” (Crow, 2002). While still in their initial stages of development, much attention has been paid to the technical and administrative components. This paper examines the usability of the interfaces of two of the most commonly used institutional repository systems: DSpace and Eprints. By using heuristic evaluation and usability testing, eighteen undergraduate students were tested using a between subjects experimental design. Measures included time for completing tasks, the number of errors, and users’ satisfaction from post-test questionnaires. Results of the study indicated that DSpace users spent less time completing tasks and made fewer errors than Eprints users. Overall satisfaction of DSpace was also higher than Eprints. Based on this analysis of problem areas, the study suggests guidelines for institutional repository interfaces.

Introduction

Most academic researchers currently create intellectual output, such as research papers or teaching materials in digital form. Some even disseminate their research through the Internet by posting these digital documents on personal web sites. At the same time, they maintain digital materials in their own computers, or other storage devices, such as CD-ROMs. This form of dissemination and management of digital research information casts doubts on the effectiveness of the current scholarly publishing model based on the strategy of peer review and a carefully managed publications workflow ending in a printed publication. The current structure of scholarly publishing does not sufficiently satisfy the users’ need for broader and faster access to scholarly information. Nor does the

existing system support the librarians' need for sustaining both traditional and electronic journal services in a period of increasing journal prices and flat library budgets. In addition, uncertainty over who will be responsible for the preservation of these licensed digital journals increases the uncertainty of long-term access to these resources. All the aforementioned problems have led to the creation of new expectations in the academic community and the desire for a new model of scholarly publishing. In such environments, digital institutional repositories, "collections that capture and preserve the intellectual output of universities" (Crow, 2002), are considered an innovative approach, which captures and preserves the intellectual output of a single or multiple university community. Institutional repositories provide two rationales: (1) to complement the existing scholarly publishing model; (2) to serve as tangible indicators of a university's quality and increase its visibility (Crow, 2002). Since institutional repositories are still at a beginning stage, the number of implementers in the U.S. and abroad is still limited.

For institutional repositories, two types of open-source software applications are most commonly used: DSpace and Eprints. DSpace was developed by MIT libraries and Hewlett-Packard and its current version was introduced in May 2003. Eprints was developed by the computer science department of the University of Southampton, in the UK, and its current version has been available since December 2002. DSpace is widely adopted by libraries in the U.S., whereas Eprints is commonly used in the European and Australian library community. One study compares these two software applications deployed at the University of Glasgow institutional repository with respect to administrative functionalities (Nixon, 2003). The study suggests that both DSpace and Eprints have a number of features in common and they work as complementary products that enable the university to collect different types of scholarly information with different challenges. However, there is little research on comparison of those two software applications from a users' perspective. This is the motivation for the present study. This paper compares the user interfaces of DSpace and Eprints and focuses on users' performance in designated tasks involving searching digital documents. The study also measures users' satisfaction of those interfaces. Since this paper investigates the usability of search interfaces in DSpace and Eprints, findings of the study demonstrate the areas where users experienced difficulty in searching for specific digital documents. These problem areas add to the knowledge of criteria for evaluating search interfaces in institutional repositories of all kinds.

Literature Review

Experimental methods have commonly been used to investigate usability issues. Chen and Dumais (2000) developed a user interface that organized web search results into hierarchical categories. This interface was compared with a typical ranked list interface of search results using the same set of tasks, search engines and search results. The experiment was within-subjects design and each subject performed the same 30 tasks. Dependent variables were measured in respect to both subjective and objective measures. Subjective measures included ratings of the two interfaces and open-ended questions about the best and worst aspects of each interface. Objective measures included search time, accuracy and interactions with the interface, such as hovering and displaying web pages. In both measures, the category interface was found to be superior.

In addition, a follow-up study was conducted by Dumais, Cutrell and Chen (2001) to examine the advantages of category groupings by comparing four category interfaces and three list interfaces. In this experiment, the authors added more context to list interfaces and removed context from the category interfaces. The results of this experiment also indicated that all tests of the category interfaces were faster than the list interfaces. Even in the case when both the list and the category interface contained category names, the performance of the list interface was slower than that of the category interface. This finding demonstrated that the presentation of category information was important for successful searching. The best performance in the category interfaces was accomplished when both category names and page titles were available.

Hornbaek and Frokjaer (2001) also investigated the advantage of structured documents and they compared the following three interfaces for reading electronic documents: (1) linear interface, which presented a linear sequence of text and pictures; (2) fisheye interface, which made sure that the parts of the document considered most important, were always readable while the remaining parts were initially distorted and (3) overview+ detail interface, which showed both a linearly presented text and pictures as well as an overview of the document. For all three interfaces, two types of tasks were performed: essay tasks and question-answering tasks. With tasks and interface types as independent variables, the study employed a 2x3 factorial design and within-subjects design. Dependent variables were effectiveness, satisfaction and efficiency. Effectiveness was measured in respect to the grade received for the answers to the tasks. Satisfaction was measured as preferences and users' comments. Efficiency was measured as time usage derived from log data. The results indicated that the linear interface, the most common interface in practical use, was inferior to both the fisheye and overview+detail regarding most aspect of usability.

Callahan and Koenemann (2000) examined the usability of the Electronic Product Catalog (EPC) on the web. They evaluated 16

automobiles EPC with hierarchical interfaces and developed a test search interface. Then this interface was compared with the InfoZoom interface, which was a hierarchically structured and zoomable EPC. For both interfaces, the content of automobile information was identical. The experiment used a between-subjects design. Dependent variables were completion rate, accuracy, completion time and satisfaction. The completion rate and completion time was significantly higher in InfoZoom than in the test hierarchical system. Overall satisfaction of both systems was high. The results indicated that performance data suggested that users valued their interaction with infoZoom more than the hierarchical system, although both interfaces had positive evaluation with respect to users' satisfaction.

Yee et al. (2003) compared two interfaces for browsing and searching digital image collections. One baseline interface was based on keyword-based image search and an alternative interface used hierarchical faceted metadata, which enabled users to navigate along conceptual dimensions of images. The authors employed a within-subjects design and dependent variables were measured in respect to user satisfaction, task success, confidence in the results, the number of dead ends, and levels of recall. For those measures, the faceted metadata interface was found to be superior.

This literature review suggests that structured and/or zoomable search interfaces were more usable, although those interfaces have not been commonly employed in many search interfaces currently in use. In addition, most of the studies focused on useful display of search results but few of them examined the design of the query entry interfaces. In consequence, the present paper focuses on the usability problems of the query entry interfaces and the design of the retrieved results page in Space and Eprints.

Methodology

This study tested the user interfaces of DSpace and Eprints at the Australian National University (ANU) institutional repository. These two interfaces were freely available on the web and based on the same set of digital documents. In fact, ANU started its institutional repository using Eprints and then became involved in a project that employed Google searching for the content of institutional repositories based on DSpace. For that project, ANU decided to deploy DSpace and replicated all the digital documents in Eprints in DSpace. Therefore, ANU now implements both the DSpace and Eprints institutional repository applications.

Tasks

Ten tasks were developed for the study. As can be seen in Table 1, tasks include nine searching tasks and one browsing task. The searching tasks included five tasks using a simple search form and four tasks using the advanced search form. In Eprints, two types of a simple search were provided: one consisting of a single box, and the other of three search boxes. Thus, out of the five tasks using simple search, one task for Eprints was conducted using the single-box search form and the remaining four tasks were performed using the three-box simple search form. In DSpace, there was only one simple search form that consisted of one single search box. Therefore, all five simple search tasks in DSpace were conducted using the single-box search form.

Table 1. Task names, descriptions and difficulty levels

Simple search tasks	Task 1: Title Task*	Search for a document with its entire title
	Task 2: Recent Document Task*	Search for the most recent document concerning deforestation
	Task 3: AIDS Task*	Search for a document with three pieces of information: author name, year and topic (AIDS morbidity in Uganda)
	Task 4: Copyrights Task**	Search for a document with two keywords (legal and copyrights) and author name
	Task 10: 2003 Task*	Search for a document with two keywords (human rights and abortion) and year (2003)
Advanced search tasks	Task 5: Conference	Search for conference proceedings with two title words

	Task**	copyrights) and author name
	Task 10: 2003 Task*	Search for a document with two keywords (human rights and abortion) and year (2003)
Advanced search tasks	Task 5: Conference Proceedings Task**	Search for conference proceedings with two title words (European Union and Enlargement)
	Task 6: Subject Terms Task**	Search for a document with two subject terms (commerce or international relations) and two title words (nuclear and arms)
	Task 7: Two Authors Task**	Search for a document with one subject (cosmology) and two author names
	Task 9: Thesis Task**	Search for a bachelor's thesis concerning expert systems
Browsing task	Task 8: Browsing Task*	Identify the number of documents in a subject category

Each task consisted of three steps. The first step was searching for documents on a given topic and choosing one specific document that was most relevant to the task. The second step required finding specific information in the abstract of the selected document. The last step demanded opening the digital document in PDF form and finding information within the document. This final step was designed to make subjects open and view the actual document. Finding the information in the document was not a significant part of the task due to the fact that both DSpace and Eprints provided exactly the same PDF document.

In order to see whether each task would be performed better in DSpace or Eprints, heuristic evaluation for each task was conducted. Since each task required using certain features of the DSpace and Eprints user interfaces, those features were evaluated based on Jakob Nielsen's 10 usability heuristics: (1) simple and natural dialog; (2) speak the users' language; (3) minimize user memory load; (4) consistency; (5) feedback; (6) clearly marked exits; (7) shortcuts; (8) good error messages; (9) prevent errors; (10) help and documentation (Nielsen, 1993).

Table 1 presents task names, short descriptions and different difficulty levels across ten tasks. As can be seen, five tasks are assumed to be more difficult in DSpace: (1) Title Task; (2) Recent Document Task; (3) AIDS Task; (4) 2003 Task; (5) Browsing Task. Most tasks using a simple search form are presumed to be more difficult in DSpace than Eprints. In addition, remaining five are assumed to be more difficult in Eprints. The tasks include (1) Copyrights Task; (2) Conference Proceedings Task; (3) Subject Terms Task; (4) Two Authors Task; (5) Thesis Task. Those tasks are mostly designed to use an advanced search form.

In the Title Task, both the DSpace and Eprints groups were asked to use the simple search form with a single box. Both groups were given a title of a document and asked to find the document. The design of the single box forms in DSpace and Eprints looked almost the same except for the length of the search box. The search box in Eprints was approximately three times as long as the one in DSpace. The longer search box helped users see what they were entering when putting in several search terms. Given that the Title Task demanded the use of several title words, the longer search box better informed users about what was happening. That is, the longer box search form provided better feedback than DSpace's simple search form. Thus, it was assumed that users would perform Title Task better in Eprints than DSpace.

DSpace users employed a single-box simple search form and Eprints users employed a three-box simple search form in the following four tasks: (1) Recent Document Task; (2) AIDS Task; (3) 2003 Task; (4) Copyrights Task. In Recent Document Task, subjects were asked to find a specific document concerning a certain topic, the one created most recently. In the AIDS Task and the 2003 Task, the year of the document's creation was given to users to search for the document. Those tasks were assumed to be performed faster in Eprints than DSpace because Eprints provided a search box for year so users knew they were able to use 'year' as a search term. In addition, Eprints provided the document's creation year in a search result page, whereas DSpace did not. DSpace provided submission dates, which indicated when the documents were submitted to DSpace. This design violated the natural logic of users concerning what information would be displayed in the search result page. Thus, the DSpace search result page seemed to fail to

make natural dialog with users.

The Copyright Task was designed to force users to conduct an “OR” search with three search terms. Since the default search delimiter of DSpace was OR and that of Eprints was AND, the Copyrights Task would be easier to perform in DSpace. In Eprints, users had to make an extra effort to choose the “OR” option to conduct the task. This design would reduce the efficiency of doing the task.

In addition, subjects were asked to use an advanced search form in the following four tasks: (1) Conference Proceedings Task; (2) Subject Terms Task; (3) Two Authors Task; (4) Thesis Task. As seen in Figure 1, the advanced search form in DSpace consisted of three search boxes and three pull-down menu listing search parameters, such as keywords or titles. In contrast, the advanced search form in Eprints consisted of nine search boxes, three drop-down boxes, and one pull-down list. Each object represented one search parameter, such as title, abstract, subject, conference and so on.

The design of Eprints advanced search form did not fulfill several heuristics suggested by Nielsen. First, the complex advanced search form did not provide simple and natural dialog. In addition, some of the search options were not represented as users’ language, such as refereed or status. Also, once users chose one of the options provided in the drop-down box, it would not be back to the initial unselected stage unless users pressed either a reset button at the bottom or a refresh button in the web browser. This design had users trapped in the search form and it did not provide a clearly marked exit. The advanced search form was also error-prone, particularly in the author search box. The author search box designated the format of author name when users used both first and last name. The format was “last name, first name”. If users just submitted a first name then a last name without quotation marks, they did not get any results. Therefore, the advanced search tasks were assumed to be more easily performed in DSpace than Eprints.

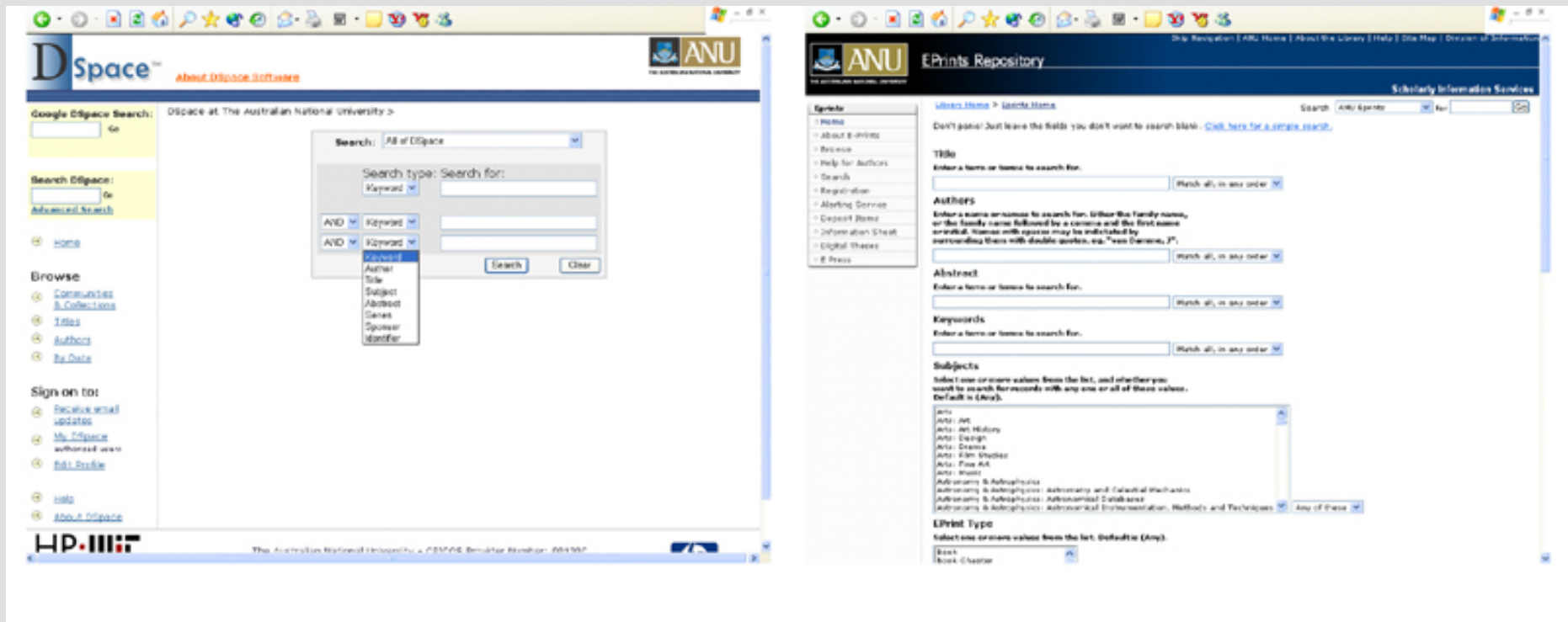


Figure 1. Advanced search form in DSpace (left) & the upper part of the advanced search form in Eprints (right)

The Browsing Task had obvious ease of completion for Eprints users because the task in Eprints was merely finding the number of documents in the subject category displayed in an initial page shown to the users. However, in DSpace, it required taking more steps to find the number of documents in the given subject category.

Based on the heuristic evaluation, it was assumed that using a simple search form and search results page in DSpace would be more confusing, whereas using the advanced search form in Eprints would be more difficult. However, overall problems in the advanced search form in Eprints seemed to be larger than those in the simple search form and the search result page in DSpace. Therefore, the following three hypotheses were proposed.

- H1: Users will spend less time completing tasks in DSpace than Eprints.
- H2: Users will make fewer errors in DSpace than Eprints.
- H3: Users' satisfaction of DSpace will be higher than Eprints.

Experimental Design and Procedure

In order to examine actual users' response to those systems, lab experiments were conducted. The experiments used a between-subjects design. The independent variables were the two user interfaces, DSpace and Eprints. The dependent variables were time for completing tasks, the number of errors, and users satisfaction from post-test questionnaires.

Before starting the experiment, subjects were asked to sign on a consent form and fill out a pre-test questionnaire including questions about demographics and computer skills. Then instructions were given on how to perform the task. Each task consisted of three steps. Subjects were shown a sample work sheet including a dummy task, such as "Search for documents concerning XYZ and find a document concerning ABC". I explained that for each task, a worksheet containing three steps of the task would be provided. Then I noted that before starting each task, I would let subjects know where to begin. After that, I explained that I wanted them to read each step out loud before beginning that step. Next I noted that when subjects thought they finished the step, I wanted them to say "I found it", and then would move on to the subsequent step and repeat the sequence. The reason for this procedure was to measure time taken in each step. After the instructions, subjects began the ten tasks. Both the DSpace and Eprints subject groups performed the same set of tasks in a different order based on a 10x10 Latin Square. Camtasia was used to do screen capture of subjects' search with their voice. After completing the tasks, subjects were asked to fill out a post-test questionnaire concerning user satisfaction. After that, post-test interviews were conducted to ask the most and least useful aspects of the user interface and their willingness to use it if the University of Michigan library implemented the interface. The interviews were audio-taped.

Participants

Eighteen undergraduate students participated in the study. Nine subjects were assigned to use DSpace and the remaining nine to Eprints. Although there are only nine subjects in each condition, usability experts have found that 80% of usability problems can be found with as few as four or five users (Brink et al, p. 434-5, 2002). This study, however, should be viewed as an initial investigation to identify general design principles suggested by users' problems. The DSpace group included four male and five female undergraduates. Their average age was 21.1. Three studied social science, two studied engineering, one majored in music and three had not declared their major yet. In addition, data about self-rated computer skills were collected using a 1-5 scale. DSpace users had expertise using word processors, e-mail, and searching for information on the web. However, they had little knowledge of programming language and creating web sites. In the Eprints group, there were four male and five female undergraduates. Their average age was 20.5. Eight studied social sciences and one had not declared her major yet. The level of self-rated computer skills of Eprints users was almost the same as those of DSpace users.

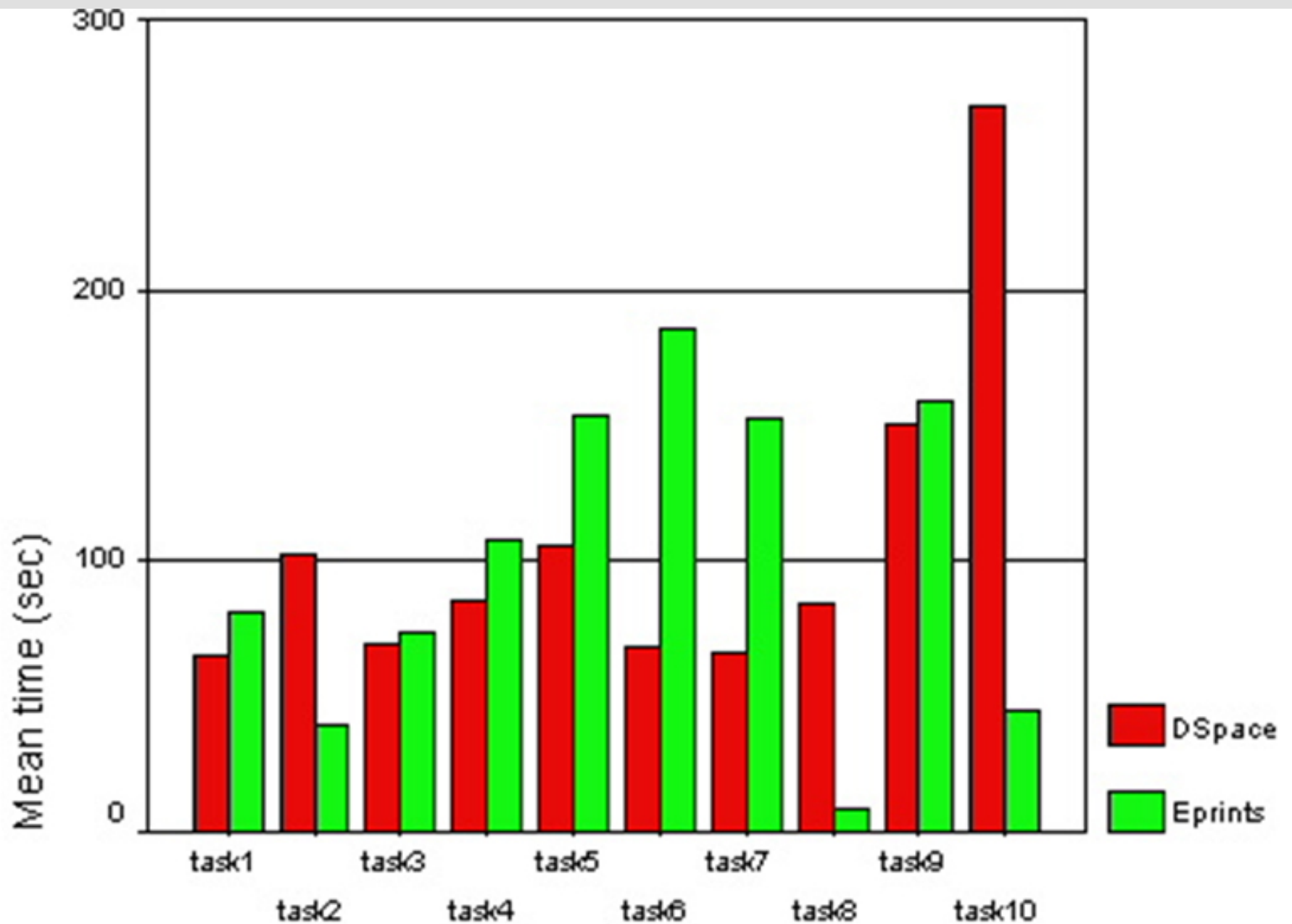
Findings

Data captured by Camtasia was analyzed to examine time for completing tasks, mouse actions, keystrokes and the number of errors. Post-test questionnaires were also analyzed to see users' satisfaction level of DSpace and Eprints. Post-test interviews were transcribed and used as complementary data.

Time Completion

Figure 2 shows average time to complete tasks in both DSpace and Eprints. The completion time was measured as time between subjects' starting the task to their finding the information in the abstract of a specific document. The reason for excluding time to open and view the digital document was that particularly in Eprints, some subjects did not open the document and provided erroneous answers in the description page. In addition, some of the links to the document in Eprints did not work. Because of these variations, the time to open and view the document was not included in the total time to completion measure. Figure 2 suggests that DSpace users spent less time completing all tasks except for Tasks 2 (Recent Document Task), 8 (Browsing Task) and 10 (2003

Task) than Eprints users. In the heuristic evaluation for tasks, Tasks 1 (Title Task) and 3 (AIDS Task) were also assumed to take more time in DSpace than Eprints, but this was not the case in the data analysis.



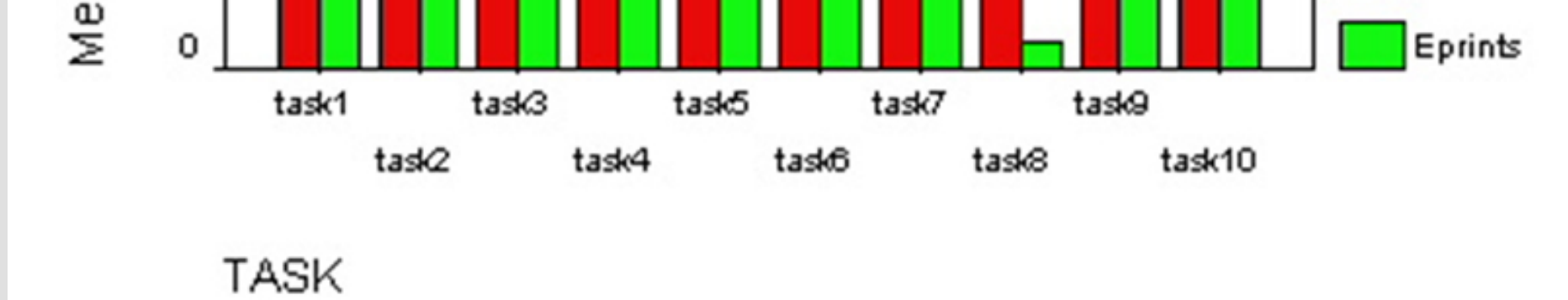


Figure 2. Completion time in DSpace and Eprints

In addition, system response time of both DSpace and Eprints testing systems was measured using the 'ping' command in a DOS-prompt window (Start:Run:CMD). The ping command simply sends four packets to the destination station asking it to respond, and then reports how long each response takes. Since all experiments were conducted from 1pm to 9:30pm, the ping test was performed in the time period. The results showed that both DSpace and Eprints testing systems had almost the same response time, averaging 208 milliseconds. Therefore, the difference in system response time between the two systems was not a factor in the measure of time to completion.

In order to see whether there was a significant difference in time completion between DSpace and Eprints, the Mann-Whitney test was performed. The test is used as a non-parametric alternative of the independent two-sample t-test. The results of the test indicated that there was a statistically significant difference in time to complete Tasks 2 (Recent Document Task), 6 (Subject Terms Task), 7 (Two Authors Task), 8 (Browsing Task) and 10 (2003 Task). Table 2 shows p-values of those tasks generated from the test.

Table 2. P-values from the Mann-Whitney Test

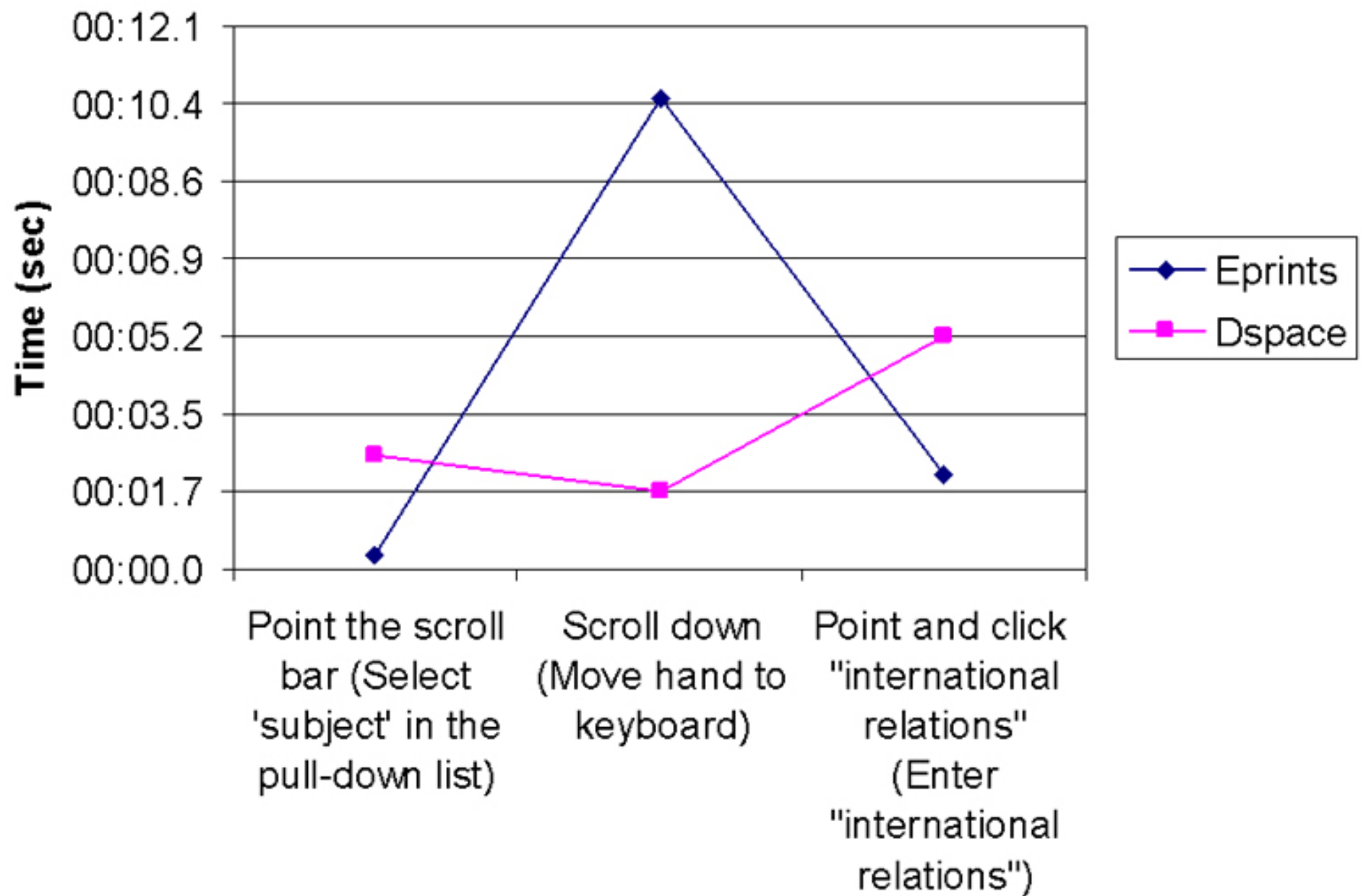
Task name	P-value (2-tailed)
Recent Document Task	.008
Subject Terms Task	.004
Two Authors Task	.008
Browsing Task	.000
2003 Task	.001

$P < .05$

As seen in Figure 2, DSpace users spent much less time completing Task 6 (Subject Terms Task) and Task 7 (Two Authors Task). In Tasks 2 (Recent Document Task), 8 (Browsing Task) and 10 (2003 Task), however, Eprints users spent much less time. To understand reasons for the said apparent differences in time, each task was analyzed in greater detail.

Subject Terms Task

The Subject Terms Task required using two subject terms, 'commerce' and 'international relations', and two title words, 'nuclear' and 'arms' as adjacent words to search for a specific document. The subjects were asked to use an advanced search form. In order to use subject terms for the search, DSpace users selected the 'subject' parameter in a pull-down list, moved their hand to a keyboard and entered subject terms. However, Eprints users went to the subject drop-down box, scrolled it down and selected the subject terms listed in the box. Figure 3 compares time taken between the process of using the given subject terms, 'international relations' in



"international
relations")

Figure 3. Average time in the process of using subject terms 'international relations' for search in Subject Terms Task at DSpace and Eprints

In DSpace, the process consisted of the following steps: (1) selecting 'subject' in the pull-down list; (2) moving hands to the keyboard; (3) entering 'international relations'. In Eprints, the process included the following three steps: (1) pointing to a scroll bar in the subject drop-down box; (2) scrolling down; and (3) pointing and clicking on the subject terms, 'international relations'. The average time taken in those steps at DSpace was 9.4 seconds, whereas the mean time of the steps at Eprints was 12.9 seconds. As seen in Figure 3, scrolling down the drop-down box to select 'international relations' took 10.5 seconds on average. Therefore, using the drop-down box in Eprints was the pivotal action that consumed subjects' time when completing the Subject Terms Task. In Figure 3, the X axis represents each step of the process. The steps for DSpace are presented in parentheses.

Another factor that affected the amount of time spent in Eprints was errors. Errors were defined as any action that did not lead to any results. Out of nine DSpace subjects, only one subject made an error, which resulted from the selection of an inappropriate search parameter, 'series' as opposed to 'subject' or 'keywords'. The subject noted that he thought series meant more than one word, such as a series of words. Since 'international relations' consisted of two words, he used the search parameter. However, series in DSpace actually meant a set of documents with the same title. This error indicated mismatch between a system's and users' perspective.

In the Eprints group, five out of nine subjects made errors; three subjects made one error, one subject made two and one subject made ten errors. The subject that made ten errors spent 9 minutes to complete the Subject Terms Task. At first, she did not recognize the subject drop-down box so she entered the subject terms in the title search box, which led to no results. Then she found the subject drop-down box, but she did not know how to choose multiple subject terms in the drop-down box. Thus, she just selected one search term, which caused another error. After that, she tried different search options in the advanced search form, such as types of document, which were not relevant to completing the task. In addition, if users chose a certain option in any of the drop-down boxes in the search form, they could not cancel their previous selection unless pressing a reset or refresh button in the web browser. Also, the search form provided default AND combination of all selected options. Thus, if users made a wrong choice and did not cancel it,

they kept encountering errors. This subject was stuck in that frustrating situation. Later she went back to the main page, clicked on the link to the 'advanced search form', and restarted the search. Other subjects made a couple of errors and most of these errors resulted from the fact that they did not know how to choose multiple subject terms in the drop-down box. Only four of the Eprints subjects knew that they had to use a control key to select two subject terms. One subject, who knew the method of using drop-down boxes, made one error because she put given title words, 'nuclear' and 'arms' in the 'abstract' search box. The subject noted that she wanted to see whether she could get the same result as entering the terms in the 'title' search box. However, she did not have any result when putting the title words in the 'abstract' search box.

In sum, using the Eprints subject drop-down boxes took more time than simply entering search terms in the DSpace search form. Since most Eprints users did not know how to use the drop-down box correctly, they made many errors, which affected another time delay. In addition, the various search options in Eprints advanced search form impeded selecting appropriate search options in an efficient way.

Two Authors Task

The Two Authors Task required using one subject term and two author names to search for a specific document. In Eprints, the task could be done by either selecting the subject term in a drop-down box or entering the term in the 'keywords' search box. Out of five Eprints users, three entered the subject term in the keyword search box. They did not even regard the subject drop-down box even if the task worksheet mentioned 'the subject of cosmology'.

Similar to the Subject Terms Task, errors were found to increase the time spent in Eprints. While DSpace subjects did not make any errors in the Two Authors Task, six Eprints subjects made a few errors when they were entering given the authors' names, "David Schade" and "Richard Ellis". As noted earlier in the task design of methodology section, the Eprints search form required using a certain format of full author name, which is "last name, first name" or using only first name or only last name. In the Eprints' group, one subject entered two authors' names using the designated format but he did not get any result. After deleting one author name, he had a set of documents including the one that he was asked to find. The other subject entered only the last names of both authors but she separated them using a comma: "ellis, schade." Then she did not get any results. Another subject misspelled one of the

authors' last names and had no results. After encountering these errors, the Eprints subject easily recovered from the errors, such as using one author name. However, making these errors caused the subjects to spend more time completing the Two Authors Task in Eprints than DSpace.

Browsing Task

The Browsing task required finding a number of documents in a given subject category. This task was obviously easy for Eprints subjects because Eprints displayed the number of documents in each subject category. Thus, any extra step would not be needed to complete the task in Eprints. The mean time for completing Task 8 in Eprints was only 8.8 seconds, which showed the obvious ease of the task. In the DSpace interface, browsing a subject category required two steps: (1) clicking on the link for the subject category; (2) clicking on a 'title' button among three buttons (title, author and by date). Since those buttons were arranged below another a single search box, some DSpace subjects were confused when deciding whether they had to enter search terms or click on one of the buttons to complete the task.

Recent Document & 2003 Tasks

Both the Recent Document and the 2003 Tasks required using a simple search from and the document creation date was the key information to identify a specific document. Since DSpace presents submission dates as opposed to creation dates on its search result page, DSpace users encountered problems when identifying which document was created most recently or in 2003 while performing both tasks.

In the 2003 Task, for instance, subjects were given two search terms, 'human rights' and 'abortion' and year of the document creation, 2003. The display of submission dates basically confused subjects when they observed the search results. In addition, since the DSpace simple search form used 'OR' as a default search function, subjects retrieved more documents when they entered more

search terms. Thus, if subjects entered all the given search terms, 'human rights abortion 2003', they retrieved 627 documents. Since all these documents presented almost the same submission dates, 19-May 2004 or 28-Sep 2004, on the first search results page, three of the DSpace subjects kept clicking and viewing subsequent pages, until reaching the end, to see whether they could find a document with the year 2003. One subject actually decided not to complete this task after viewing the results pages and not getting a document created in 2003. Also, two subjects used the 'by date' option under the 'Browse' menu on the left side. The 'by date' option provided a search box that allowed users to search for a year. It also provided pull-down lists of month and year, which enabled users to jump to the point of the year in the search result page. This option, however, was based on the submission dates and using this option did not help subjects complete the task. In the post-test interviews, all the DSpace subjects mentioned that the submission dates confused them. They suggested the year of document creation should be displayed in the search result page.

Overall, DSpace users spent less time completing tasks than Eprints users, and therefore, the first hypothesis of the study was accepted. However, there was a significant difference in the time spent to complete the five tasks. In three tasks, DSpace users spent much more time than Eprints users. In the remaining two tasks, Eprints users spent much more time than DSpace.

Number of Errors

Table 3 shows averages and standard deviations of errors that occurred during the tasks in both DSpace and Eprints. As can be seen in Table 3, DSpace users made fewer errors than Eprints users while completing the tasks. Therefore, the second hypothesis of this study was accepted.

Table 3. Number of errors in DSpace and Eprint

	DSpace	Eprints
Mean	4.9	7.1
Standard Dev.	4.76	7.00

User Satisfaction

Data about users' satisfaction was collected from post-test questionnaires, which contained 5 sections with 23 questions based on a 0-9 scale. The five sections included (1) overall reaction; (2) web page; (3) terminology and web site information; (4) learning; (5) web site capabilities. Out of the 23 questions, 5 questions had at least one 'Not Available' answer. Table 4 shows the average level of satisfaction collected from questions in each section of the questionnaire.

Table 4. Mean and Standard Deviation (SD) of user satisfaction in DSpace and Eprints (0-9 scale)

	DSpace	Eprints
	Mean (SD)	Mean (SD)
Overall reaction	6.5 (0.23)	6.0 (0.82)
Web page	7.7 (0.69)	7.0 (0.85)
Terminology & web site info	7.2 (0.81)	5.7 (1.61)
Learning	6.9 (0.49)	6.0 (1.62)
Web site capabilities	7.6 (1.28)	7.0 (0.48)

In general, user satisfaction of DSpace was higher than Eprints. Therefore, the third hypothesis of the study was accepted. However, the results of the Mann Whitney test concerning user satisfaction showed that there was no significant difference in the satisfaction level between the two systems.

Discussion

Findings of this study suggested several problem areas of both the DSpace and Eprints search user interfaces. Problematic areas mainly concerned the design of query entry forms and the search results pages. The identified problems elicited criteria or guidelines for evaluating the design of search user interfaces in digital institutional repositories of all kinds.

Adequate number of search entry

DSpace subjects mostly preferred the advanced search form as opposed to the single-box search form, whereas Eprints users tended to prefer the three-box simple search form to the advanced search form. DSpace subjects commented that using the single-box search form sometimes provided too many search results like the case of the 2003 Task, but they did not know how to narrow down their search by using the search form. Eprints users mentioned that although the advanced search form worked well, it provided too many search options to choose from. Thus, they noted that they might start using the three-box simple search form and if they did not find any result by using the simple search form, they would switch to use the advanced search form. In this respect, the complex design of the advanced search form seemed to discourage user usage. Users also did not like the one-box simple search form with no information on how to use it.

Provide examples of search queries

The one-box simple search form in DSpace was not considered useful because it did not provide any instruction or examples of how to use it. The instruction was available in a 'help' documentation in DSpace but no one referred to it even when they had trouble. In contrast, Eprints provided short instruction about how to formulate queries above each search box. Although Eprints users made more errors than DSpace users, they easily escaped from the errors after reading the short instructions. However, when DSpace users had trouble, recovering from the errors was difficult. One of the DSpace users doing the 2003 Task even skipped the question after wandering around the web site for several minutes. Therefore, information about how to enter search terms would help users make fewer errors or recover from the errors.

Employ users' language

Although DSpace users preferred the advanced search form, they commented on the difficulty of understanding some of the search

parameters, such as series, identifiers or sponsors. One DSpace user kept using 'keywords' for all types of search terms. He noted that using only keywords as a search parameter would be the most logical way to go, and seemed much easier than searching through titles, authors or years, which were considered 'keywords'. Eprints users also had difficulty making sense of some search options, such as referred, types or conference. In particular, subjects were not very aware of the different genre of scholarly information, such as thesis or conference proceedings. One Eprints subject mentioned that types of documents would be the least useful search option for him. He said if he was looking for some information, he would probably be looking by subject and the type of document in which he found it would not matter. The importance of document types might vary for other subject groups, however. For instance, a documents' genre would be considered more important to faculty groups as opposed to undergraduate students.

User control and freedom

Eprints users were frequently stuck when using the advanced search form. Using the reset button was the best way of solving the problem, but the reset button was located at the very bottom of the long advanced search page. Therefore, the Eprints users did not recognize the existence of the reset button and never used it. To escape the trap, they pressed the refresh button in a browser, or went back to the first main page and clicked on the link of 'advance search form'. This problem indicated that how to effectively present the given functionality was key to the success of user interfaces.

Useful components displayed per result

All DSpace users mentioned that submission dates were the most confusing elements when doing the tasks. The components of retrieved results should help users understand enough about one result to distinguish it from others. Therefore, displaying document creation dates would be helpful to select relevant documents.

List search results in a useful way

The DSpace search results page seemed to show the most relevant documents on the top, although DSpace did not specify how it listed the retrieved results. Therefore, in most tasks, the document that the tasks required to find was displayed on the top. In Eprints, the default sorting option was by title and users could choose other types of sorting options, such as authors or years. However, one Eprints subject mentioned that there was 'no order' of displayed results so that it was difficult to find one specific document. The reason she felt that there was no order was that Eprints sorted the title of results by the very first word. The very first word even included articles, such as 'a' or 'the', which were usually excluded for sorting. This way of sorting would be possible to be confusing to other users.

Clearly present a link to open a digital document

Some users in Eprints did not often recognize the link to open and view a digital document, whereas DSpace users never failed to open the document. In DSpace, the link was displayed in a separate gray box, which helped users easily recognize it. The link label was 'open/view', which made it easy to understand what the link would show. In Eprints, however, two types of links were provided: one was labeled as 'PDF' and the other was represented as hyperlink of the exact URL with a label of 'alternative locations'. Eprints users recognized either one or the other to open the document. Some Eprints users also suggested that the 'PDF' link should be designed to be more recognizable by using different labels or bigger size of characters.

Conclusion

The present paper identified the usability problems of two user interfaces of digital institutional repositories, DSpace and Eprints. The comparison suggested that the DSpace interface would be better and more usable than Eprints. Both systems, however, proved to be difficult to use in different areas. Those problem areas revealed what should be accomplished for search user interfaces. Therefore,

the study suggests seven guidelines for evaluating search user interfaces: (1) give users an adequate number of search options; (2) provide examples of search query; (3) employ users' language; (4) allow users greater control and freedom; (5) display useful components in result sets; (6) list search results in a useful way; and (7) clearly present links to open digital documents. Implementing these guidelines would improve the user's experiences when using digital institutional repositories.

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